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ABSTRACT

This research raised two main methodological problems. The first is that practices and theoretical concerns associated with what may be referred to as "social, cultural, political approach," which integrates a critical perspective in mathematics education, are still at the margins of the realities of mathematics classrooms. That is, they are not widespread in the current mathematics education system and readily available for investigation. Hence, the methodological concern is that of producing a research design and process that brings these theoretical ideas into the realm of practice. This problem is addressed by allowing researchers and practitioners to imagine a hypothetical situation inspired by a theoretical landscape, and to create an arranged situation for research, by intervening in some existing, current actual situation. The second concern is to develop an appropriate methodology in which the research processes and practices are consonant with the educational processes and practices. That is, the theoretical underpinnings and commitments of a critical approach to mathematics education need to be maintained within the research approach. To this end, a critical approach to research in mathematics education is explored through a series of key issues in the third part of this paper, which were identified in undertaking such research. (Contains 31 references.) (Author/KHR)

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Re-searching mathematics education from a critical perspective

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Abstract: To undertake such research raised at least two methodological problems, which are discussed in this paper. The first is that practices and theoretical concerns associated with a what may be referred to as social, cultural, political approach which integrates a critical perspective in mathematics education, are still at the margins of the realities of mathematics classrooms. That is, they are not widespread in the current mathematics education system and readily available for investigation. Hence, the methodological concern is that of producing a research design and process that brings these theoretical ideas into the realm of practice. This problem is addressed by allowing ourselves (researchers and practitioners) to imagine a hypothetical situation inspired by a theoretical landscape, and to create an arranged situation for research, by intervening in some existing, current actual situation. The second concern is to develop an appropriate methodology in which the research processes and practices are consonant with the educational processes and practices. That is the theoretical underpinnings and commitments of a critical approach to mathematics education need to be maintained within the research approach. To this end a critical approach to research in mathematics education is explored through a series of key issues in the third part of this paper, which were identified in undertaking such research.

Introduction

The idea that mathematics and mathematics education could or should somehow be quite directly and explicitly connected to issues in society is now well established. It is possible to sketch a wide theoretical landscape of a social, cultural, political approach to teaching and learning mathematics. This landscape, comprises at least four developments in mathematics education: a critical mathematics education for and by all; and a critical ethnomathematics education; concerns about dimensions of diversity including race/culture, gender, class, and language; and people's mathematics in people's education for people's power from the Apartheid era. Taken together these may be interpreted as offering a critical perspective in mathematics education. Arguably, these ideas that could be said to constitute a social, cultural, political approach to a mathematics curriculum are far more developed in theory than in practice. Hard evidence to support (or refute) theoretical propositions about empowerment, emancipation, democracy, social justice, equity and so on through mathematics education are still rather thin. Moreover, a commitment to these kinds of theoretical ideas also needs to include a concern for making such ideas more widely available to practitioners for interpretation and critique. This has created an imperative to begin to consider the means by which to investigate such an approach to mathematics education.

Throughout the paper I illustrate and give meaning to the ideas I develop with reference to my research[1]. The research question I was interested in was: what happens in a mathematics classroom when student teachers who have been introduced to a social, cultural, political approach to the teaching and learning of mathematics, which integrates a critical perspective, attempt to realise such an approach. Student teachers are typically introduced to new ideas in teacher education curricula with the implicit assumption (or hope) that they will somehow integrate these ideas into their teaching. A co-operative collaboration with them offered an opportunity to take a closer look inside classrooms, to examine what meaning is given to these theoretical ideas in practice. In this process the student teachers would learn to teach by teaching in a new and different way. This opportunity created the means for myself, as the teacher educator, and the student teachers (and the class teacher) to reflect on both the theoretical ideas introduced in their coursework and the forms they take in practice. In this paper I do not focus on the findings of the study but rather seek to open discussion on methodological concerns that arose in conceptualising and undertaking the study.

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In essence this was a study in theory-practice relations in mathematics education but here the focus is on that relation in research. I use the term theory rather broadly to refer to a network of ideas and concepts in a theoretical landscape, which, in particular, explains an approach to the school mathematics curriculum that focuses on social, cultural and political aspects and integrates a critical perspective. What are the means for one to say anything – critical or supportive - to this approach, its theoretical basis, and to any associated practices, especially when these are not readily available? Once produced, what are the sources for developing any theory and associated practices further?

Actual, hypothetical and arranged situations

Distinguishing these three "situations" assists in describing and clarifying a process of researching innovative theoretical ideas and practices in mathematics education from a critical perspective[2]. I take these situations to offer theoretical tools for thinking and talking about researching a theory-practice relation when a particular theoretical landscape and related practices are deliberately introduced into a context because these are not dominant in the mainstream educational setting.

The actual situation

This is the situation that actually exists: in a class, a school, a teacher education institution or even the educational system as a whole. In a significant amount of research in mathematics education, some aspect of the current, existing, actual situation is researched: learners, teachers, texts, curricula and so on. That is, researching *what is.*

There are at least two ways in which the theory-practice relation in this research could have been investigated by referring to the actual situation. First, I could have searched for an actual situation in which, for example, teachers are working with the curriculum approach I am interested in studying. This would be quite a challenge given the dominant existing modes of mathematics teaching and learning in South African classrooms. A description of the actual situation, currently in South Africa can be characterised as one in which authoritarian modes of interaction and transmission teaching dominates, with rigid adherence to the mathematics syllabus strongly tied to tests and examinations and all of which largely occur in under-resourced large classes (see for e.g. Naidoo 1999). Although not all schools or classrooms fit this description, what has been described as a social, cultural, political approach is not a feature of the actual situation in the vast majority of South African classrooms. A second approach may be to study and interpret the actual situation as it occurs, through the lens or theoretical framework of a critical perspective in mathematics education (see for example Cotton, 1998). In this latter approach to the research I could consider issues of democracy, equity, social justice, etc. in actual situations as they are currently played out in mathematics classrooms. By studying *what is*, we may produce ideas for *what could be* or *what ought to be.*

In my research, the actual situation is not considered directly. It is important to the extent that I together with other participants could intervene in an actual situation and arrange a situation for research. Knowing the actual situation is, however, important for the analysis and theorising later to explain what occurs in the arranged situation. My research interest lies in making a concerted effort to introduce prospective teachers to a particular theoretical landscape and its associated practices and then to examine its recontextulisation when facing the reality of classrooms. The focus is not on the existing actual situation per se but rather on some new and different situation that is organised and created with ideas from a particular theoretical landscape.

The hypothetical situation

To posit a hypothetical situation assumes that the link between a theoretical landscape and practices associated with it, is not direct. It is mediated by what we allow ourselves to imagine could be. The hypothetical situation represents an ideal situation being thought of by

the researcher or teachers who are engaging the theoretical landscape. It contains hypothetical ideas, concepts and also related examples of practice which are selected and reinterpreted from the theoretical landscape according to their understanding of the context in which the practice will take a particular form. It is constituted by what is imagined by the various research participants. We could also think of the hypothetical situation as the "recontextualising field" (Bernstein 1996) through which there is a de-location from the theoretical landscape and a re-location into practice. It is distinguished from a theory or theoretical landscape, which contains a certain network of ideas and concepts developed with reference to and offering explanations about what happens in a variety of contexts. These theories vary in distance from the context under consideration in the research being undertaken. For example student teachers are studying theories and practices developed in Denmark or the USA which must be re-conceptualised and re-interpreted for the general South African context and for a particular setting such as urban or rural. It is precisely for this reason that the hypothetical situation is important since it offers a space for reforming or transforming elements from the theoretical landscape. Perhaps it could also be called the "situation of hope" or the "hoped-for situation" because it offers inspiration for envisaging changes in the actual situation. No doubt the hypothetical situation has its source in the theoretical landscape that the researcher wants to investigate but also includes other ideas arising from the context. It is the situation imagined by the researcher and informed by the ideas and concepts in the theoretical landscape. A researcher constantly interprets and reinterprets a theory and its fundamental ideas and concepts throughout the research process according to the actual situation she is confronted with.

In my research since the student teachers were seen as co-researchers, their interpretations also belong in the hypothetical situation. The hypothetical situation in this study constitutes my understanding and that of the student teachers, of the theoretical landscape that sketches a critical social, cultural, political approach to mathematics education. This also includes our ideas of related educational practices such as project work. The hypothetical understandings and interpretations of the different participants in the research are not in any sense equal as they have different vested interests in the theoretical landscape and in the associated practices, and therefore also play out differently according to the differing power relations of the researcher and research participants in the situation being created. This means that all is not harmonious in the hypothetical situation, which could contain conflicts and contradictions. For this reason hypothetical situations are essential for investigating a critical perspective in mathematics education because they also assist in mediating the imposition of an intervention and allow for critique and dissent from all participants.

The hypothetical situation is also not static as it is likely to be constantly developing and changing through what happens in the school and classroom contexts. The student teachers' understanding of a social, cultural, political approach to mathematics education (see Vithal 1997) gives some indication of the student teachers' hypothetical thinking and reasoning before entering the school or classroom and to some extent the theoretical landscape that I have constructed does the same for me as a researcher. This hypothetical situation is also dynamic in that it changes as the proximity to the classroom increases. For instance, shifts in student teachers hypothetical thinking and reasoning are discernible as they approach the situation to be arranged and as they begin to negotiate with the class teacher for the opportunity to try a new or different approach in the mathematics lessons. That is, the hypothetical situation for the student teachers during their coursework when the possibility to realise the approach appeared remote is different from the period when they are closer to actually preparing to do something in a school and classroom.

The arranged situation

The arranged situation is a reorganised actual situation, which is created and constituted by the researcher and research participants. It is developed with reference to ideas and inspiration from the hypothetical situation. The arranged situation may be negotiated by the researcher, but it nevertheless represents an imposition on the actual situation. This is the

case even if the intervention is considered progressive and represents democratic practices and emancipatory pedagogy. Furthermore, the arranged situation as it is developed with reference to the hypothetical situation, creates the opportunity for the researcher to see how events unfold in relation to the theoretical landscape. The arranged situation represents a temporary situation in itself, but is likely to have some lasting consequences for the actual situation which may or may not be significant.

The arranged situation in this research is one in which student teachers negotiated and realised an opportunity to 'try out' a social, cultural political approach which integrates a critical perspective, and in which the nature of interactions and the way in which mathematics is taught and learned were fundamentally transformed. The educational practice employed in this particular arranged situation was that of project work which was selected by the student teachers from the range of practices made available in this theoretical landscape. The arranged situation here could be thought of as a mathematics "curriculum development laboratory". In appropriating this image of a laboratory, a place for exploring and experimenting with a 'new' or different curriculum approach is suggested, in which all the actors and their actions are being considered. The mathematics classroom as a whole constitutes this "curriculum development laboratory" offering an opportunity for theory and practice to confront each other precisely in the place in which both must be given meaning. Through negotiation, a novel arrangement is set up in the mathematics classroom, which acknowledges and is aware of the scrutiny of a research process for a predetermined period. In the curriculum laboratory, it is possible to study the curriculum as it develops and unfolds in the classroom.

Descriptions of the arranged situation must allow the researcher to reflect on the hypothetical situation. The researched situation (which may be considered as a fourth situation) is located inside the arranged situation since the researcher may focus on some features of the arranged situation and may miss others or not be aware of the total impact of the intervention in a specific context. It could be that the researcher might choose to focus on a specific aspect of the arranged situation. Thus, only a part of the arranged situation becomes data, which is analysed, interpreted and explained, selected in relation to the hypothetical situation and the research question.

Arranged situations are needed in countries like South Africa which are attempting fundamental curriculum changes based on theoretical and hypothetical speculations through curriculum policies whose consequences are not known in the diversity of classrooms in the schooling system. Creating and studying arranged situations are also important in contexts where curriculum importation is undertaken because they open to scrutiny theoretical assumptions underpinning such curricula and the viability of their related practices, which may have remained masked in other places.

Reflections on actual, hypothetical and arranged situations

The construction of these actual, arranged and hypothetical situations offer tools for understanding and explaining the research process in investigating a theory-practice relation, in particular, one that embeds a critical perspective. While research in actual situations is closer to researching something typical or ordinary - studying *what is*, research in the arranged situation allow a researcher to study *what ought to be* or *what could be*. Researching the actual situation could also lead to studying *could be* if the researcher is able to find a situation that is in a sense ideal/exceptional or close to the ideas in the hypothetical situation. The arranged situation makes it possible to study what does not currently exist or exits only as remote theory and practices. Arranging a situation for investigating a critical perspective in mathematics education involves choice, negotiation and reciprocity. The reasons for participating need to be open and to some extent shared.

An important observation is that as a result of organising an arranged situation for research, the actual situation may never return to its original form. *What could be* can become a part of *what is*, even if only partially and incompletely so. In other words, the arranged situation could become an actual situation, but different from the one the research started with.

The main point here is that no classroom intervention can be made and withdrawn without leaving some impact, however small or large, however visible or invisible. The implication is that arranged situations, created by temporarily significantly transforming actual situations, could begin to produce 'new' or changed actual situations. The act of arranging a situation for research is not without consequence for all the participants involved. Once the research has ended, the classroom does not revert to the exact same actual situation that existed before. A 'new' actual situation, produced in the process of constructing and living in an arranged situation, through the interaction of the hypothetical situation and the actual situation that existed prior to the intervention, resembles neither the original actual situation nor the arranged situation. This means that each of these hypothetical, actual and arranged situations are dynamic in themselves, constantly changing as the unfolding events in the arranged situation force shifts in the hypothetical situation and bring changes in the actual situation.

Distinguishing the hypothetical, actual and arranged situations offer a means for thinking about how to establish and research innovative practices associated with emerging theories. In itself this is not really a special problem and there are many studies that implement and investigate interventions in mathematics education. A main concern in this study is that of the imposition that occurs when an actual situation is made into an arranged situation by taking a particular hypothetical situation into account, that is, an approach which embeds a critical perspective. While it must be acknowledged that interventions can never escape the problem of imposition, the difficulty or contradiction that occurs in this research, however, is related to how to deal with this impositional issue with reference to a particular perspective in theory, methodology and participation which argues against it in the educational setting. The problem of imposition occurs in all three situations, hypothetical, actual and arranged.

A serious contradiction arises in exploring a theory that attempts to introduce a critical democratic perspective in an education setting without it being an imposition. Yet, an imposition has to be made, in the first instance, in the hypothetical situation precisely in order to make such ideas more widely available and to understand what they can mean in reality. Participants such as teachers and students cannot be coerced into accepting the importance of such a curriculum approach or to be critical. Moreover, nor can the form, content and direction of their critique be pre-determined. In the hypothetical situation researchers and teachers select, reject and interpret ideas and concepts from a given theoretical landscape according to their understanding and interpretation of the context of the actual situation.

A second problem is a methodological one of imposing a critical perspective in the arranged situation. It may be argued that to study an innovation, it must first be carefully developed, and then implemented in a classroom or school. The very use of a term such as implementation includes an implicit implication of having to do something with little or no choice. There are several questions that have to be considered when introducing a critical approach to a curriculum. To what extent, and in what form can such a curriculum approach be developed before entering the educational setting? What are the means for bringing it into a classroom so that it becomes a shared responsibility? And who should have the main responsibility for developing and shaping this curriculum approach and be accountable for what happens within the classroom? A curriculum approach that seeks to value the intentions, participation and actions of learners in the arranged learning situation, needs to value and invite the teachers in similar ways into learning about such a curriculum approach.

A third level of contradiction resides in the actual situation. The attempt to introduce a critical pedagogy may fundamentally and significantly contradict the prevailing culture and ethos of the existing learning context. The issue here is about how much and in what ways the teachers' goals and strategies for teaching and learning mathematics in the actual situation diverge from those built into a curriculum approach that embeds a critical perspective. The established norms and traditions of the actual situation in a mathematics classroom which rest on assumptions of what teachers believe and know or do not know, and according to which they act, can be seriously challenged to differing degrees. For example, giving learners choice about their learning in mathematics can significantly conflict with teachers' (and pupils') beliefs, goals and ways of working. The issue of what constitutes the hidden curriculum of a

critical pedagogy needs to be considered in terms of how it could give learners conflicting and contradictory messages in contrast to the hidden curriculum of traditional pedagogy.

One approach to the problem of imposition is that choice, negotiation, reciprocity and reflexivity must be key features, theoretically and methodologically, in a critical perspective. But this can mean that the distance between the hypothetical and arranged situation increases, as negotiation with the actual situation always involves compromises. For instance, the researcher may find it difficult to recognise key features of the new curriculum approach in the arranged situation according to her hypothetical understanding and reasoning.

These theoretical and methodological concerns provide a means for discussing the potentiality of situations, to describe and create a narrative about a future situation. It allows us to describe a future context for acting, for teaching and learning mathematics. However, the descriptions of potentiality themselves are in tension with the actuality of situations. This is because the theoretical concepts and ideas in the hypothetical situation are not rooted in actual situations but in the idea of potentiality. This potentiality is derived from theoretical and practical considerations in the theoretical landscape but given life through interactions with reality in the arranged situation. Moreover, many of these considerations in the theoretical landscape are from contexts which are different from the actual situations in which the study is located. However, theoretical concepts and ideas need not only be imported, they may also grow from arranged situations. It is precisely the opportunity to imagine a potential situation that this research attempts to offer and is one of the most important reasons for creating an arranged situation. Possibilities imagined in both theory and practice arise from descriptions of arranged situations. A constructive confrontation between concepts and criteria from theory (or the hypothetical situations) and concepts and criteria from practice (the arranged situation) can bring advancements in theory and in practice (or in new actual situations). From this potentiality of situations, emerge inspirations for new hypothetical, actual and arranged situations.

In summary, my main concern so far has been to primarily address the question of finding a methodology that allows one to investigate an approach to the school mathematics curriculum that by and large is not found in the current system. To this end, I have constructed theoretical tools for explaining a methodology for investigating a social, cultural, political approach to the school mathematics curriculum. Through these theoretical methodological tools it is also possible to engage the inherent contradictions of intervention and imposition of a critical perspective in mathematics education. By setting up a meeting between a theoretical landscape and practice, the opportunity to bring new meanings to a curriculum approach that integrates a critical perspective could be realised. This in turn has the potential to improve both ideas for theory and practice. The question still to be addressed is what should be the fit between a theoretical landscape which integrates a critical perspective and a research methodology that seeks to investigate the landscape itself? This second question will now be discussed.

A critical approach to mathematics education versus a critical approach to research

In this part of the paper I raise issues that I consider to be necessary (but by no means sufficient) in seeking a methodology for investigating an approach to mathematics education that integrates a critical perspective. I do this by using three broad well-known categories: positivist, interpretivist and critical paradigms in research which serve as a map for the rest of the discussion and for locating my research concerns. I then discuss what may be considered a serious difficulty in researching a critical perspective in mathematics education – that of a researcher trying to find consonance between her research approach and her educational approach. The search for a research methodology for mathematics education from a critical perspective takes two routes – one into mathematics education and the other outside it – which is reified through the discussion of some key aspects in the relationships between the researcher, the research participants and the research process.

A distinction quite commonly made between different research approaches in the literature is: a) the empirical-analytical, logical positivist or behaviourist paradigm; b) the

interpretive, hermeneutic, phenomenological or symbolic paradigm; and c) the critical paradigm. These categories have been imported into research discussions in mathematics education in various ways by writers such as Romberg 1992; Nickson 1992 and Kilpatrick 1988[3]. This classification is one of many, and not in any way exhaustive, we need only refer to the growing research debates related to postmodernism and feminism. Nevertheless, the first paradigm has dominated mathematics education research as a glance at journals reporting research in mathematics education show. In recent years, with the strong emergence of constructivsm, the second paradigm has also gained much ground. However, if the research journals and the recent handbooks published in mathematics education (see Grouws 1992; Bishop et al 1996; Sierpinska and Kilpatrick 1998) are taken as indicating the state of the art in research in mathematics education then it is reasonable to conclude that the critical paradigm is significantly under-explored and under-represented in mathematics education research. In positioning my research it seems quite logical, even natural, that a critical perspective in mathematics education must surely reside in a critical paradigm. But what exactly is a critical research paradigm? And what relation, if any, could it have to a critical perspective in mathematics education?

A main purpose of this study is to explore the relation between a particular theoretical educational approach and its recontextualisation into practice by student teachers. The educational approach has been described as a social, cultural, political one, which integrates a critical perspective, and I constructed a particular research process through which I explored its realisation in a mathematics classroom. A question that arises from the description of the research process is, what is the underlying theoretical base supporting the empirical work and methodology? The question may be extended to: what is the relation between the theoretical assumptions upon which the research process is based, and the educational theory that is being examined in its interpretation into practice? Indeed, what could or should be the nature of the relation between the educational theory being investigated and the "research theory" – the theoretical underpinnings that inform the construction and enactment of the range of research practices within an empirical study?

Typically, the theoretical framework set out in a study provides the theoretical tools by which the data will be analysed. Is it possible to explore a deeper, more broader link between the theory underpinning educational practice and the research process itself in all its facets: such as in the nature of the question asked, the relation between the researcher and the researched, the involvement of the research participants in the activity of data generation, and the criteria for verification and evaluating the study. The assumption being made here is that just as there is no neutral and value-free mathematics education, the research enterprise is neither neutral nor value-free. The problem then is to not only understand the assumptions which (dis)connect theory and practice in education but also the theoretical assumptions that underpin the research methodology through which that link is explored and understood – the theory and practice of the research itself.

In the way in which the above questions are framed, one could posit a separation within the theoretical considerations in an empirical study. That is, a possible disjuncture between the educational theory and its practices and processes on the one hand, and the research theory and its practices and processes on the other. The research paradigms distinguished above can assist in making visible the theoretical assumptions in the research process and the fundamental ideological differences in how research is understood, engaged and its goals achieved. The theory-practice relation in the different research paradigms, as Carr and Kemis (1986) state, is understood differently. In positivist research "theory is regarded as a source of disinterested principles which...may be taken to prescribe for action". In interpretative approaches to research, interpretations do not prescribe action but "merely informs teachers about the nature, consequences and contexts of past actions, and require that practitioners use their own practical judgement in deciding how to act". From a critical perspective, the relation between theory and practice "is seen to require the active participation of the practitioners in collaborative articulation and formulation of the theories imminent in their practices and the development of these theories through continuing action and reflection" (ibid.: 152)

To explore further the issue of theoretical considerations in research methodology and its link or disjuncture from theoretical considerations in education consider the

following from my research. Perhaps an approach to the research could have been to develop a set of criteria or prescriptions from the theory to guide the student teachers, to follow this with classroom observations and interviews with them, and then to analyse the data against a predetermined set of indicators of this critical perspective to mathematics education. The idea that a set of criteria or indicators can be found and applied in the research process comes into a serious and significant contradiction with the theoretical positions within a critical mathematics education and conflicts with the educational process. That this is observed as a conflict, of course, depends on how a critical perspective in mathematics education is understood. Taking a critical perspective in mathematics education cannot be equated to, as Skovsmose and Nielsen (1996) point out, "a sort of methodological principle". Critical mathematics education does not refer to a particular form of mathematics education but rather to a perspective in an educational landscape which involves mathematics. As such, it cannot be outlined as a set of rules for action and content and then followed in order to realise a 'critical mathematics education' (Skovsmose and Nielsen 1996). The problem can be concretised more sharply. In the educational theory, a particular educational relationship is argued for between teachers and pupils, for instance, pupils cannot be 'forced' to learn or become critical. The question to be considered is then similarly, what should the research relationship be between researcher and teacher, for instance, teachers too cannot be 'forced' to take a critical perspective in mathematics education. Hence, the difficulty is that whilst the educational theory is located in a critical paradigm, the theoretical underpinnings in the research could become lodged in a positivist paradigm. My experience in trying to investigate a critical perspective in mathematics education is that this conflict arises quite easily if the theoretical assumptions on which the research is based is not explicitly considered by the researcher in the research process, and its connection to the educational theory is not explored and maintained. What needs to be understood is how and what mediates the way in which a researcher understands the theory-practice relation and chooses to act in particular ways as a researcher, and in constructing research relationships. In this research it has to do with my views about what constitutes a critical perspective in mathematics education versus the research paradigm in which I locate myself as a researcher.

One difficulty in grappling with these problems is that the literature on critical mathematics pedagogy seldom makes its research methodology explicit. In the review of research and literature on ethnomathematics Gerdes admits that "Ethnomathematical - educational research, including the study of possible educational implications of ethnomathematical research, is still in its infancy" (1996: 927). Much of the attention, as can be seen in the work of Frankenstein on a criticalmathematics literacy, is focused on advocating a critical approach to mathematics education, and developing a theoretical base for the approach and related educational practices. Skovsmose (1994) develops his theory of a critical mathematics education by referring to teachers' descriptions and not his observations. More recently critical mathematics education is used to refer to both "educational practices as well as to research on this practice" (Skovsmose and Nielsen 1996: 1260) and it is suggested that research in critical mathematics education can be largely identified with ethnography and action research. This is not to say that descriptions of research processes do not exist. What has still not been adequately developed are a set of reflections at a meta-level in research that begin to put forward a coherent and comprehensive theoretical framework for doing research in this mathematics educational landscape. In the next section I attempt to initiate such a discussion by tentatively marking out some means for making these reflections and identifying some issues for consideration, particularly as they arose in my research.

Sources for developing a research methodology for a critical perspective in mathematics education

There appears to be at least two sources for developing a research methodology for a critical perspective in mathematics education - one from inside mathematics education and one from outside.

The search inside mathematics education

A source inside mathematics education for developing a methodological base for researching a critical perspective in mathematics education is to consider the corresponding educational landscape itself i.e. to draw on theoretical formulations within mathematics education that elaborate a critical perspective which could inform the research process. These may be sought in the work of Skovsmose (e.g. 1994), Frankenstein (e.g. 1987), D'Ambrosio (e.g. 1990) and others who write to develop a theoretical base for a critical perspective in mathematics education. For instance, Skovsmose and Nielsen identify several "concerns" of a critical mathematics education such as "Critical mathematics education concentrates on life in the classroom to the extent that the communications between teacher and student can reflect power relations" (1996: 1257). This could also become a concern in a critical mathematics education research methodology in the relation between the researcher and the research participants (as I will elaborate later). Several other concepts such as 'reflective knowing'/'knowing as an open concept' may have a parallel interpretation in research as reflexivity; 'intentionality' in learning may give insights into understanding the interests of the research participants in the research process; and the notion of 'exemplarity' could provide alternative meaning to the issue of generalisation in this study. What may be observed here is how concerns and concepts in the educational landscape could be recontextualised in the research landscape. This means that the hypothetical situation serves both the researcher and the practioner in recontextualing ideas from theory both for practice and for research.

A counter to this proposition may be that the task, goals and discourse of education must be distinguished from those of research - there may be overlap but they are essentially different human activities. The dilemma, however, is that in preserving this necessary separation, the researcher runs the risk of seriously contradicting the democratic project at the heart of her study. This correspondence between research and educational theory is not only desirable but is essential if a mathematics education theory that is concerned with questions such as, "Does mathematics education reproduce inequalities ... (that) are reinforced by educational practice?" (Skovsmose and Nielsen 1996: 1261) is not to become implicated in reproducing or reinforcing forms of inequality in the research processes and methodology employed to study those theories and related practices. The main thesis here is that any study that puts issues of democracy in the centre of an educational theory must equally be concerned with issues of democracy within the research process itself. A theory, which draws attention to the politics of mathematical knowledge as an integral part of mathematics education, must concern itself with the politics of knowledge production within the research enterprise that seeks to investigate such ideas.

The search outside mathematics education

A second source comes from the progress that has been made in developing and using such research approaches outside mathematics education, in response to similar kinds of questions. A critical mathematics education research methodology could draw on the advances made in methodological issues from outside mathematics education because critical perspectives in mathematics education are inspired by and rooted in a critical paradigm, and draw on the work of those same theorists/theories outside mathematics education. Ethnomathematics, feminist and critical mathematics educators draw on the work of theorists such as Freire, Giroux and others who are proponents of critical theory and perspectives. This means that further elaboration can be found by examining the relation between research and educational theory as it has developed outside mathematics education. There seems to be agreement that (educational) theory and practices that locate themselves within in a critical paradigm must be investigated through methodologies which are themselves located in a critical paradigm. I draw on the writing of Robert Young and Patti Lather who deal with this dilemma.

In *A Critical Theory of Education*, Young identifies the need to "re-theorise or reconstruct general methodological understandings in educational research" and the problem of employing research methodology informed by positivist ideas in studies to investigate critical education: "The existing literature theorises the activity of researchers in

epistemological terms and not as social agents. That is, for the most part, educational researchers are theorised as privileged epistemological actors within a theoretical model which is conceptually quite distinct from the theory in which the behaviour of teachers Twenty-two points, plus triple-word-score, plus fifty points for using all my letters. Game's over. I'm outta here. and pupils is theorised." (1990: 138-9). The clear implication is that there should be some kind of harmony between the educational relationships advocated in a particular theory and the research relationships constructed in the research process. But what does such a research methodology look like and how does one create a correspondence between the theoretical or epistemological base of the educational and research processes and practices?

Going outside education, this issue is perhaps most directly and succinctly discussed by Lather in her paper "Research as Praxis" (see also Lather 1991) in which she explores "the methodological implications of the search for an emancipatory social science". She writes "The essence of my argument, then, is that we who do empirical research in the name of emancipatory politics must discover ways to connect our research methodology to our theoretical concerns and commitments. At its simplest, this is a call for critical enquirers to practice in their empirical endeavours what they preach in their theoretical formulations" (1986: 258). A key aspect of what is described as an "emancipatory approach to research", an approach that is "explicitly committed to critiquing the status quo and building a more just society" (ibid.: 258), is the relation between the researcher and the research participants and the form in which this relation gets express through the research process in the generation of the research question, the data, the analysis and theory and even the writing of the research report. The main point to be gleaned from this, for the discussion at hand, is that whatever the understanding of democracy, creating a research process that is characterised by democratic concerns is essential in a study that itself puts issues of democracy in the centre of educational theory and practice. Researchers who involve the research participants in a democratised process of inquiry, according to Lather, engage in research that features negotiation, reciprocity and empowerment. In this way she argues, empowering approaches may be developed to the generation of knowledge. However, as she also points out there are few clear strategies for linking critical theory and empirical research. One approach is to build in opportunities for reflexivity into a critical enquiry at all levels in the research process not only for the researcher but also for research participants.

It is possible to observe, across writers, that to take a critical perspective in theory and practice, means also to take a critical perspective in research. They argue that ways must be found to make this connection and refer to the growing phenomenon of critical research (see for e.g. Cherryholmes 1991; Carspecken and Apple 1992). Two examples of methodologies linked to critical research are action research (see for e.g. Carr and Kemis 1986) and more recently critical ethnography (see for e.g. Quantz 1992, Kinchloe and McLaren 1994)

Toward a critical research methodology: some key issues

The main challenge I set out for researching a critical perspective in mathematics education earlier, I now illustrate with respect my own study - in what ways, and to what extent have I dealt with integrating a critical perspective in my research? I do so by examining different facets of the research process and forms of participation. Several key aspects are identified and discussed in an attempt to connect concerns of practice and theory in research on the one hand, and in mathematics education on the other; and for the different research participants - students teachers, class teacher and pupils - and the researcher.

1. Choice

The choice to participate in the research recognises the aspect of agency, the freedom and the capacity to decide to act, which must be considered, given its central role in a critical education setting. In the research, student teachers were invited to participate as co-researchers to investigate what for them was an innovative, even radical approach to teaching and learning mathematics. Sample selection was based on voluntary participation involving student teachers

interested in the opportunities the research provided; who were familiar with the approach and had some understanding of it; and who were to some extent committed to the ideas of the curriculum approach under scrutiny. Several preparation session were held prior to the students entry into schools which provided students with information about the study, so that the choice for their involvement could be informed and based on their willingness, interest and commitment to the educational ideas and the research process. Just as I created an opportunity for joint ownership of the research question, some student teachers created similar opportunities for their learners to own their project problems. So learner interest, a key idea in a critical approach to education, paralleled the student teachers' interest in the research. Notwithstanding, interests themselves differ and are vested in different ways in different parts of the process.

The choice to participate is followed by the choice to shape that participation. This is observed in the choice excercised in the interpretation of the approach within the arranged situation. Although at the beginning of these preparation sessions I had left open the educational tasks and ideas for implementation (for e.g. critical literacy tasks involving newspapers - see Vithal 1997), in the discussions that followed and in school they focused on project work. That is, although the research focussed on investigating a social, cultural, political approach to the mathematics curriculum, the student teachers reshaped that focus to project work as its main interpretation in practice. Within project work, further choices were made, for e.g. in handling the teaching and leaning of mathematics. The dilemma was should it be taught first and then ask learners to apply it or could it be learned as a part of the process of working in the project. In dealing with such dilemmas, my relationship to the student teachers reflected the role of a teacher-supervisor in project work that they were attempting to model in their projects. The student teachers, for instance, give the learners a relevant chapter from a textbook to deal with the mathematical issues that arose in the projects. Such a radical deviation from the conventional approach was negotiated and tried. But was it also in some sense imposed?

There are also the choices that researchers make throughout the research. By the time teaching practice ended I was not able to be present in the classes for three of the projects. This had serious consequences in that these projects were somewhat marginalised in my study. Even though I explained my lack of equal physical presence in the projects to the student teachers and the way in which I was making the choices, this was, however, not without consequences especially for my relationship with the student teachers and the projects not visited regularly, and for those student teachers' lack of participation in later activities. Within the research process itself student teachers chose to collect data and participate in an initial analysis in order to produce a paper for a conference. Drawing on Skovsmose's (1994) notion of intentionality and learning as action, it may be argued that learners learn when they own the reasons and goals to learn. Similarly, student teachers' engagement in the research process was also mediated by their own interest to become researchers and/or practitioners. Student teachers who expressed a strong interest in doing research, collected far more classroom data than other student teachers. After teaching practice, it was these student teachers who drove the process for writing and presenting the paper which came to be a powerful means to see themselves as intellectuals and generators of knowledge.

Choice is an important element in researching a critical educational perspective and essential for participants in the research process because it constructs them as free agents in that should their experience of the research process become in anyway exploitative they could withdraw or change the nature of their participation. This freedom to choose, however, is bounded since it is exercised within other constraints, such as the requirements of their teaching practice course for their degree and the commitment to the school. Choice assists the researcher to not fall foul of practices that are contradictory to the theory on which the research rests. It serves to counter, in part, imposition that any negotiation might lead to especially when the researcher is in an inherently more powerful position than the participants because of the unequal balance of knowledge and skills specific to the situation and to research itself. Choice is also essential if participants are to maximise their participation in the research especially in terms of the effort and commitment that any

successful research project requires. The postulating of a hypothetical situation, which offers a space for mediating between theory and practice, supports the element of choice in that the recontextualisation of theoretical ideas need not be uniform or consistent within or across research sites, though they may be negotiated. Choices are shaped by hypothetical reasoning to anticipate actions in the arranged situation.

2. Negotiation

Once the choice to participate is made, there are different kinds of negotiations related to different aspects of the research endeavour that need to be negotiated. First there is the negotiation of research relationships and identity among the different participants: student teachers, learners, teacher and researcher. These must be managed both with reference to the research situation and the educational setting which comprise the arranged situation. My relationship to the student teachers is foregrounded in the study and for each of the students in the study it is different, not least because our histories are both similar and different given our multiple identities in terms of race, class, gender, age, etc. I was aware through their reflections and evaluations that they identified with me in different ways at different times as a teacher educator, a fellow teacher, a researcher, a woman, and as a friend. The research process allowed greater closeness than usual during normal supervision in teaching practice. This relationship underwent further change during the course of the study with a closer relationship developing with those students in whose project I was present a great deal more whilst a distance emerged between those students for whom I was not there. Six students who did not participate in writing the paper, were almost all students whose projects were on the margin. From the outset of the research project I emphasised a relationship of colleagues jointly interested in the same research question.

Once the choice to participate is made, participation has to be negotiated given the different vested interests and identities of the researcher and research participants in the educational and research endeavour. Although I construed the student teachers as co-researchers this belies the unequal knowledge, skills, interest and participation in the research. I declared my dual role of researcher/teacher educator and debated how these could be managed. The student teachers and I shared an interest to know the outcomes in real classrooms of these new theoretical ideas and practices developed in other countries discussed in their teacher education course. However, as their teaching practice supervisor I was required to give an assessment during the research process. Hence, assessments were opened to negotiation. Some student teachers showed extraordinary commitment to the research project. They were very enthusiastic and constantly talked to each other and to me about their ideas, especially those who showed a strong interest in being involved in research themselves. Other students were sceptical because the ideas were considered to be radical, but they were curious about its possibilities and therefore interested to participate. The student teachers in turn, entered negotiations with the teacher and with learners in school to realise a different approach. The preparation sessions held prior to meeting the teachers and learners, and continuous post lesson reflections during the research prepared student teachers for their negotiations and confrontation with the actual situation and to assist them in arranging a situation in a school during teaching practice. These also gave an indication of the student teachers' and my hypothetical understandings and interpretations of the theory and practice under investigation, and a space for a continuous process of negotiation. Negotiation of participation involves also a negotiation of practice. Despite drawing student teachers attention to other forms of practice, they focussed on project work. However the project work itself took different forms and evolved through negotiations in the arranged situation relating to both the actual and hypothetical situations and for both educational and research considerations.

Negotiation is the key to creating the possibility for change. Negotiation allows a situation in which, whatever the idea that is put forward by the researcher and by the participants, it has the status that it can be challenged, critiqued, discarded, reformed or transformed. This means that the quality of reasoning both in the practice and in the theory may be improved. Negotiation is essential and central to the relationships between the

hypothetical, actual and arranged situation. Firstly, between the ideals of the hypothetical and the reality of the actual situation, the researcher and research participants need to negotiate their creative pedagogical imagination to develop possibilities for action in practice. Secondly, for a workable and realistic interpretation of the hypothetical situation into the arranged situation, a collaborative transformation of the actual into the arranged is needed. Thirdly, negotiation enables theorising to occur from the ground in the arranged situation, back into the hypothetical situation, and to the a priori theoretical landscape. Throughout these relations, negotiations serve to enhance the quality of the participation of the research participants and therefore of the research. However, negotiation is not without its problems. Given the inherently unequal power in research relations, negotiation itself can dilute different perspectives and contradictions in seeking consensus to act in a particular situation.

3. Reciprocity

Reciprocity ensures that the goals and outcomes of the research process will meet the needs and interests of both the researcher and the research participants. Given the availability of choice and negotiation, reciprocity keeps at bay the possibility for the research process to collapse by helping to secure the commitment and participation of the research participants in the arranged situation. It assists in bringing equity to the research partnerships since both are seen as needing something the other can offer which in turn contributes to effort and commitment. All involved participants should have a clear idea about what is in it for them in the research process. Through reciprocal partnerships, participants are made accountable to each other even if that accountability lies in different domains and interests. It is in reciprocity that the ethics and politics of research are reified and the aspect of rewards and reasons for participation need to be dealt with. Unequal power and differing vested interests make reciprocity crucial in critical approaches to research. In my research, rewards were offered that the participants could decide on in negotiation with me. Of the several suggestions discussed, student teachers chose to jointly write a paper about their experience in the project and participate or present at a conference. Nevertheless, I still recognised that the power relations operated in my favour by virtue of my status as researcher and teacher educator, and nor was I able to apply these concerns in equal measure to the teachers in the school and especially to the pupils in study. Even offering rewards are not without their difficulties since, in themselves, they constitute a power-induced intervention mediated between the researcher who has the authority and power to reward, and those who receive that reward.

Despite having employed many of the strategies similar to those described by critical researchers, I was aware of the inherent hierarchical nature of the relation with the student teachers. In both these settings of researcher and teacher educator I was often construed as the one who should know. Having discussed at length various alternatives for a particular classroom situation in the project work, student teachers still asked for my opinion as an "expert" – "What do you think? Am I doing the right thing?" Thus, in the teaching and research process, where student teachers are learning to become teachers of a critical approach to mathematics education and are also participating as novice researchers, the power relations operate in favour of the teacher educator and researcher. However, there are spaces where this is reversed or equalised, for instance, during discussions of practice related to knowledge about the learners and classroom organisation issues (such as how to arrange the groups in a particular class or what to do with a specific group or student). These shifting power relations are at work throughout interactions between the researcher and the research participants. It is important to recognise this because it influences what data are produced and how these are analysed, especially when the student teachers are also involved in the analysis and writing.

The question is to what extent were my suggestions, in fact experienced by student teachers as impositions. There appears to be an inherent paradox in critical research described by Lather as follows: "The potential to create reciprocal, dialogic research designs is rooted in the intersection between people's self understandings and the researcher's efforts to provide a change enhancing context" (1986: 269). The problem is

that whilst the researcher and the research process seek to avoid being impositions (but inevitably are), at the same time the research participants need to be empowered to think and act in new and transformed ways. For the student teachers it was a constant struggle between traditional ways of thinking, acting and being mathematics teachers, and their new role as supervisors or facilitators in project work. And this struggle played out within the constraints of how the school views and organises mathematics teaching, learning, assessments etc., as well as their role as student teachers in subject matter areas other than mathematics.

Throughout the research process I sought to respect the views of the research participants no matter how much they differed from my own as opportunities were created for the ideas in the theoretical landscape to find expression. But this also meant being confronted with racist and sexist views and views that condone corporal punishment. The research process required staying in dialogue with the student teachers, challenging them to be innovative, supporting and building on their own ideas, yet also developing their capacity to critique not only what was happening in the classroom but also their own deeply held beliefs and values. One of the most important considerations in designing the research was to construct a partnership that did not exploit the participants in the research process. This reciprocity concern, however, was not extended in equal ways to teachers and learners in the research. In return, I remained open to the possibility that my deeply held beliefs and the heart of my research concern that mathematics education has a role to play in building a democratic and just society and that cultural, social, political issues can and should be discussed in mathematics classrooms, may be seriously challenged and completely shattered when faced with the reality of mathematics classrooms and schools. Choice, negotiation and reciprocity are important features not only in methodology but also in criteria for evaluating such research, such as in democratic participatory validity, which requires the researcher to make visible the extent to which the research participants participate in the research (see Vithal 2000).

4. Reflexivity

Reflexivity opens for constant critique in research and in the educational setting. Opportunities for reflecting on the arranged situation were made available through: a) various interviews with student teachers, both in the project and outside, and the class teacher; b) data generated by the pupils in the class which included their diaries, work done on projects, charts produced and any other written material; c) through presentations made by the student teachers to a PhD reference group and a faculty research seminar; and d) the production and presentation of a joint paper at a national conference for mathematics education (see Vithal et al 1997). Reflections on the arranged situation are important because they give us the means by which to connect back to the hypothetical and actual situations and to seek shifts in these. Involving multiple levels and points for reflections and involving different participants both in the centre and at the margins in the research and educational processes gives rise to a reflexivity which brings both an insider-outsider perspective, and opens opportunity for self-critique. Student teachers responded differently to critique from me, the class teacher and their peers who were assisting in the project work. The student teachers' involvement in these research activities demonstrate how spaces for reflexivity may be created in the arranged situation and as they leave it to return to the actual situation. Moreover they have methodological implications because they contributed to an early and initial analysis of the data. The issues they identified in these reflections were debated and discussed and through these processes became part of my analysis in the research. They showed how hypothetical situations were changing and therefore also how they would act in an actual situation and in a newly created arrange situation.

Reflexivity is needed for managing the multiple identities of the researcher and research participants. Throughout, I was acutely aware of my shifting framework for observing and interacting as I grappled with and tried to understand what it meant to be both the researcher and the teacher educator. For instance, when standing at the back of the classroom with the video camera, I was to all intents and purposes a non-participating

observer. That immediately changed when the student teacher asked my opinion about something or if the pupils drew me in with a question. A significant difficulty was in trying to simultaneously reflect and understand what was going on as a researcher while at the same time acting as a participant in the process as a teacher or teacher educator. The position I adopted as far as the classroom interactions were concerned was to participate, if I was invited by the student teacher or the pupils. The researcher/teacher educator dilemma also emerged in the post lesson discussions as I presented alternative solutions and strategies from the ones the student teachers were considering which were usually informed by a traditional mathematics pedagogy. Reflexivity serves to flatten the hierachy of relationships in research and in the educational environment because all reflections are considered and valued.

Reflexivity makes possible more equitable theory-practice relations and allows for the development of both theory and practice through shared reflection and critique. The post lesson discussions provided strong opportunities for reflexivity and joint analysis, on a regular basis, of what was going on in the classroom. It was during this time that alternatives were discussed and decisions negotiated for the day to day running of the project. In writing their projects, began a preliminary data analysis process and overview of the project for each student teacher. The opportunity and process of writing the paper provided a space to reflect and more closely resembled what researchers do – having collected data, doing an analysis and writing. It was during these times that students could reflect on what had happened in the different projects across contexts, which led to alternative explanation for events observed in their own projects and affirmed or showed gaps in the theory.

This brings us to another important, but related concern about how the relation between theory and practice is constructed in the research situation and the role of the researcher and the research participants in the critique and generation of ideas for both theory and practice. Two questions must be raised here: first, how should the critique and development of theory and practice be managed in research; and second who should be involved in this process? Typically theory is priviledged and this priviledge is extended to the researcher - theory speaks to practice. Reflexivity in critical research gives practice the opportunity to speak back to theory. Both theory and practice become matters for negotiation between the researcher and the research participants. It is also for this reason that the recognition of a hypothetical situation, which mediates how theory and practice are recontextualised during the study, is important. Moreover, a critical perspective positions the researcher not only as someone who seeks to understand the research situation, but legitimates the researcher's active involvement in, and on the research situation. This means that while the researcher has an important role in sharing reflections on practice, student teachers have equally a space to reflect on their experience with respect to the theory.

Reflexivity is also essential for contexts in which there is theory and practice importation. The main focus of my research was to give meaning to a particular theoretical landscape in a context vastly different from that in which it was conceived and then to see how the process could yield new insights both for theory and practice. Thus, while the theoretical landscape led to a particular practice which generated specific data, the data in turn would come to inform the theory. Lather (1986) brings this issue to the fore by examining theory building versus theory imposition as dialectic. In this sense the dialectic of theory imposition versus theory building played itself out in my study as theory imposition creating opportunities for theory building by both the researcher and the student teachers. This point is important in that seeing theory and practice as dialectical (see Roman and Apple 1990) is not the only consideration in a critical approach to research, but also recognising that the practitioners or the research participants have an active role to play in theory building. This is however, easier said than done because what needs to be considered is the research participants' (lower) interest in theory building. For most of the student teachers, their main interest was in improving practice rather than building theory.

5. Subjectivity-Objectivity

The relationship of the researcher to the research process takes different forms in each of the positivist, interpretivist and critical approaches. In positivist educational research

the researcher is the "instrument by which research is undertaken" as an objective observer. The interpretivist researcher reconstructs and interprets events for greater understanding which "become part of the language of their time and influence(s) the decisions made by others". However, in a critical approach to educational research the researchers' "participation in the development of knowledge is comprehended as social and political action which must be understood and justified as such" (Carr and Kemmis 1986). This does not mean that these are discrete relationships. Although the relationship of the researcher to the research process may be driven by one paradigm, and in this study the critical paradigm, there are instances during which the other relationships do manifest. That is, in the practice of research, there are times when the researcher might be positioned as the 'objective observer'. However, the overall research process must itself be guided and grounded in methodology that corresponds with the theoretical commitments of the researcher.

The relationship of the researcher to the research process and the research participants has often been discussed through the debate about objectivity and subjectivity in research methodology. A rather simplified tracing of the history of this debate seems to suggest a shift from a preoccupation with and concern about establishing objectivity in research in the positivistic paradigm to a situation in which subjectivity is recognised as important and understood in a multiplicity of ways in research. There might be what is called "disciplined subjectivity", as one example in the interpretivist paradigm. This debate however rages on (see for e.g. Eisner and Peshkin 1990). Roman and Apple argue that subjectivity and objectivity should not be "treated as a binary opposition in which the absence of one is seen as the presence of the other" but rather what needs to be acknowledged is "the reciprocal determinacy that "subjectivity" and "objectivity" - the conflicting sets of historically specific power relations and material interests - have upon one another" (1990: 39). Research that is "openly ideological" (Lather 1986) or is constructed or seen explicitly as "an ethical and political act" (Roman and Apple 1990), and which attempts to address concerns for inequalities and injustices, has forced researchers to question and re-examine the "Subject-Object dualism" in new and different ways. An assumption here, is that objectivity and subjectivity are separate but in dialogue. It is possible to posit yet another approach, and that is one in which objectivity is interpreted as inter-subjective agreement - giving up any search for objectivity and settling instead for inter-subjectivity. There is no 'truth' to be found through research, but only multiple truths depending on the position taken or occupied in the research setting. But even such a position is not unproblematic since these do not all have equal status given that "meaning is jointly constructed between researchers and the research subjects in the context of interests that are formed out of contradictory power relations" (Roman and Apple 1990: 40). How researchers think about and resolve the objectivity and subjectivity positions in their individual research is important because it deeply affects how research relationships are created, the research process and procedures set up, what is accepted as data, how and who participates in the analysis and production of theory.

6. Context, Change and Instability

Perhaps what may be considered a silence or gap in discussions about critical research methodology is the question of: how is critical research context related? Does matter if the methodology is considered in Denmark or South Africa? What does it mean to do critical research concerned with issues of equity and social justice, in societies marked by rapid change, deep and structural inequalities, violence and poverty? The powerful contestations and resultant disruptions which produce instability, the heart of a critical research agenda, threaten the very existence of the research situation. What distinguishes countries like South Africa from other countries such as the USA, is the scale of the disruption and instabilty, and its location at the centre of society, involving mainstream concerns, rather than at the margins. There is an assumption about stability in research, including critical research that assumes a research situation and its participants are constantly available to the researcher.

The description of the research methodology for my research could be described as a relatively normal, steady process. There is little indication of the history of the research process, the material conditions in which it was located, or the transformations that were taking place in the context in which the research was happening. Yet the research was marked by severe and consistent disruptions and instability with strikes and protest action. Early in the study, while working with student teachers, the university closed down and the preparation sessions (which were also disrupted) replaced substantive negotiations with teachers in schools, which resulted in a more marginal participation by class teachers in the project work. Later, in schools, during teaching practice, teachers went on strike which impacted directly on how the project was realised, for instance, one project was completely abandoned. Disruptions to carefully conceived research designs are the norm rather than the exception in educational research in South Africa. Why disruptions are produced in research, how they come to feature in the research process, and what is/can be done with disruptive data has been discussed elsewhere (Vithal 1998). It may be argued that the stability assumption built into the research situation, in research methods and methodologies, are largely imported from the "north", from the more "developed" contexts, and often applied in "developing" countries in the "south" which is characterised by rapid and huge transformations in virtually all its institutions (see Valero and Vithal 1998). Such an assertion attempts to bring an analysis of power relations engaged within theory and practice, and within research and education, also to the inequalities in the production, importation, ownership and legitimation of the *means* by which knowledge is produced-the research methodologies themselves in mathematics education. Critical research has emerged in particular contexts, in response to a particular set of concerns and conditions, and is itself implicated within the larger global inequalities. The potential for more equitable dialogue is considerable, if for instance, the disruption and instability thrown in such sharp relief in the South African context is seen to bring greater focus on similar situations in other contexts where such concerns may appear marginal or marginalised. The challenge for critical researchers is to take seriously instability in research situations, both methodologically and theoretically, and to consider what it means to focus on unsanitised "disruptive data" not only as a procedural matter but substantively, both practically and theoretically. The politics of knowledge production within critical research itself may be problematised through a focus on context and the concern to theorise disruption and instability in methodology.

7. Emancipation, Empowerment and Hope

In this concluding aspect I return to a central idea of any critical education and research. What distinguishes a critical approach from other approaches to research, Carspecken and Apple (1992) write, is that the critical researcher is deeply concerned about "inequality and the relationship of human activity, culture, and social and political structures." These concerns guide the questions that are posed and the nature of the inquiry in which the critical researcher acts on the world with others "in democratic ways so that this world may change". Critical researchers make explicit that their research agenda is not only about understanding the inequalities and injustices but also includes an openly transformatory and emancipatory research agenda which means that they seek to bring some change to the participants' lives' and their contexts. Although this intention can be read in my broad research focus in the choice to select and study a particular approach to mathematics education that is concerned with empowerment and emancipation, this was not a direct or explicit goal in the research.

Nevertheless, I must address the notions of empowerment and emancipation, which have an important position in the hypothetical situation, but raise several difficulties within the arranged situation in the research. The first is that whilst a research project may claim an emancipatory intent or purpose, this cannot be predetermined. The researcher cannot know the direction, nature or content of an empowerment or emancipation nor its impact on the whole life of the participants. Empowerment in some aspect brings disempowerment in others. Second, is the inescapability of the "imposition of emancipation". Someone, usually a researcher, as insider or outsider, selects and decides to involve participants in a

research process. The focus on selection based on disadvantage and oppression in critical inquiry leads to the situation of someone in an inevitable position of power defining a group as such and beginning a research process. The third is the need for a deeper understanding of the nature of the participation of the researched in all aspects of the research process. The participants do not have the researcher's skills and knowledge and an inherent unequal situation cannot be avoided between the researcher and researched even though the researcher may act to reduce that in specific ways. This is the problem of the researcher knowing best in the research situation. A fourth problem is that of a "once and for all transformation". A main focus of critical research is the notion that the transformation that is hoped for, occurs in the research process, but what of its sustainability or transient nature. A fifth difficulty lies in seeing the research process itself as constituting the transformation. That is, the processes and practices for studying the change do not necessarily coincide with the processes and practices for making the change. The problem is that of being involved in transforming a situation and simultaneously studying it. Finally whilst no methodology is neutral, no methodology is inherently emancipatory or positivist. Rather it depends on the theoretical assumptions built into it, the way in which it is given meaning in its use within a research design and the researcher's theoretical leaning[4]. Problematising the aspects of empowerment and emancipation is not intended to discard such notions but rather to see them as located in the hypothetical situation which inspires and gives reasons and goals for thinking and acting in the arranged situation.

Rather than to speak of research carrying emancipatory intent, it may be useful speak of research as carrying possibilities and hope, an idea also put forward in the theoretical educational landscape. Although this may be interpreted as weakening a critical approach, it serves equally to address some of the difficulties mentioned above. But the question is what can the "principle of hope" found in a critical mathematics education (Skovsmose 1994) mean in a critical approach to research? I was aware that student teachers would be inducted into their first major teaching experience through a radically different pedagogy. The research situation that I arranged with them and through them created the possibility and potential for change at a number of levels and in different areas - their role as student teacher, teacher of mathematics with a new approach and so on. Whatever the intent and my direct intervention, changes are difficult to anticipate in contested unstable contexts. But still, it is the hope for change, which inspires and drives initiative and effort to arrange situations. The research situation itself revealed what possibilities (if any) there were for change and what may in fact change, even if temporarily. Distinguishing an actual, arranged and a hypothetical situation offers a means for talking about a critical approach to research that focuses on possibilities and hope, on potentiality and actuality. Even though critical researchers may enter into the investigation with their epistemological assumptions and political agenda admitted upfront (Kincheloe and McLaren 1994), sustaining these concerns throughout the research may be far more difficult.

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[1] This paper is an edited version of a section from my doctoral dissertation (see Vithal 1999)

[2] These ideas first proposed by Ole Skovsmose have been developed in research seminars in South Africa, Denmark and Brazil and become part of my PhD project through the supervision discussion process.

[3] The latter two writers refer to the last category as action research rather than as a critical paradigm. Although action research is often elaborated with respect to the critical paradigm (see for example Carr and Kemmis 1986) not all action research fits into this category.

[4] Survey research, for instance, can be used for purposes of empowerment because even though it assumes a particular relationship between researcher and researched, it can be subverted toward more egalitarian ends (Singh and Vithal 1999).

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